WHAT IS CLAIMED IS:

1. A method of producing nanostructures by phase separation during metal organic vapor-phase epitaxy (MOVPE), comprising:

providing a growth surface in a reaction chamber;

introducing a first mixture of precursor materials into the reaction chamber to form a buffer layer on the growth surface;

introducing a second mixture of precursor materials into the reaction chamber to form an active region on the buffer layer, wherein the nanostructures are embedded in a matrix in the active region; and

introducing a third mixture of precursor materials into the reaction chamber to form a cap layer over the active region.

2. The method of claim 1, wherein introducing the third mixture of precursor materials reintroduces the first mixture of precursor materials.

3. The method of claim 1, further comprising doping the first and third mixtures of precursor materials to form a p-type buffer layer and an n-type cap layer.

4. The method of claim 1, further comprising doping the first and third mixtures of precursor materials to form an n-type buffer layer and a p-type cap layer.

5. The method of claim 1, further comprising controlling at least one property of the nanostructures by adjusting at least one of the following parameters: temperature of the growth surface, growth surface material, growth rate of the active region, ratio of the second precursor materials, composition of the second mixture of precursor materials, substrate surface orientation, strain between the active region and the growth surface, and pressure of the reaction chamber,

6. The method of claim 1, further comprising introducing at least one surfactant to control at least one property of the nanostructures.

7. The method of claim 1, further comprising annealing the active region after formation of the nanostructures.

8. The method of claim 1, wherein the first, second, and third mixtures of precursor materials are introduced using at least one carrier gas.

9. The method of claim 8, wherein the flow rate of the carrier gas is adjusted to control at least one property of the nanostructures.

10. The method of claim 8, wherein the type of carrier gas is changed to control at least one property of the nanostructures.

11. A nanostructure product produced according to the method of claim 1.

12. The nanostructure product of claim 11, further comprising an active region characterized by the generic formula (group III-V)$_{1-x}$((group IV)$_2$)$_x$.

13. The nanostructure product of claim 12, wherein group III-V is selected from combinations of:

group III elements consisting of B, Al, Ga, In, and Tl; and
group V elements consisting of N, P, As, Sb, and Bi.

14. The nanostructure product of claim 12, wherein group IV is selected from the group consisting of C, Si, Ge, Sn, and Pb.

15. The nanostructure product of claim 11, further comprising a group IV nanostructure and a group III-V matrix.

16. The nanostructure product of claim 11, further comprising a group III-V nanostructure and a group IV matrix.

17. The nanostructure product of claim 11 characterized as lattice-matched.

18. The nanostructure product of claim 11 characterized as lattice-mismatched.

19. A nanowire produced according to the method of claim 1.

20. The nanowire of claim 19, consisting essentially of at least one group IV element.

21. The nanowire of claim 19, consisting essentially of a group III-V compound.

22. A nanocrystal produced according to the method of claim 1.

23. The nanocrystal of claim 22, consisting essentially of at least one group IV element.

24. The nanocrystal of claim 22, consisting essentially of a group III-V compound.

25. The nanocrystal of claim 22, characterized as having a length of less than about 20 nm.

26. A method of producing a nanostructure by phase separation during metal organic vapor-phase epitaxy (MOVPE), comprising:

providing a growth surface;

forming a buffer layer on the growth surface;

growing an active region having the nanostructure embedded in a matrix on the buffer layer; and

removing a portion of the active region.

27. The method of claim 26, wherein growing the active region comprises providing a mixture of precursor materials in a reaction chamber until the nanostructure grows to a desired size on the buffer layer.

28. The method of claim 26, further comprising phase-separating a group III-V compound from at least one group IV element during growth of the active region.

29. The method of claim 28, wherein the at least one group IV element forms the nanostructure and the group III-V compound forms the matrix in the active region.

30. The method of claim 28, wherein the group III-V compound forms the nanostructure and the at least one group IV element forms the matrix in the active region.

31. The method of claim 26, wherein removing a portion of the active region is by selective etching.

32. The method of claim 26, wherein removing a portion of the active region comprises removing at least a portion of the matrix.

33. A nanostructure product produced according to the method of claim 32.

34. The method of claim 26, wherein removing a portion of the active region comprises removing at least a portion of the nanostructure.

35. A template for fabricating nanostructures produced according to the method of claim 34.